IMPACTO DE LOS RIOS ATMOSFERICOS EN LAS PRECIPITACIONES SOBRE EL SUR DE SUDAMERICA

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ABSTRACT

This study quantifies the impact of atmospheric rivers (AR) on precipitation in southern South America. An AR detection algorithm was developed based on integrated water vapor transport (IVT) from six-hourly CFSR reanalysis data over a 15-year period (2001-2016). AR landfalls were linked to precipitation using a comprehensive observing network that spanned large variations in terrain along and across the Andes from 27°S to 55°S, including some sites with hourly data. Along the Pacific (west) coast, AR landfalls are most frequent between 38°S and 50°S, averaging 35-40 days/year. This decreases rapidly to the south and north of this maximum, as well as to the east of the Andes. Landfalling ARs are more frequent in winter/spring (summer/fall) to the north (south) of ~43°S. ARs contribute 45%-60% of the annual precipitation in subtropical Chile (37°S-32°S) and 40%-55% along the midlatitude west coast (37°S-47°S). These values significantly exceed those in western North America, likely due to the Andes being taller. In subtropical and midlatitude regions roughly half of all events with top-quartile precipitation rates occur under AR conditions. Median daily and hourly precipitation in ARs are 2-3 times that of other storms. The results of this study extend knowledge of the key roles of ARs on precipitation, weather and climate in the South American region. They enable comparisons with other areas globally, context for specific events and support for local nowcast and forecast.

Palabras clave: atmospheric rivers, precipitation, South America, rain gauges.

1) INTRODUCTION

In this work we present a comprehensive examination of the impact of ARs on precipitation in southern South America, with emphasis in the west coast and the Andes cordillera. This climatological study is important in several ways. In first place it provides a background to analyze past or future individual AR events, especially those associated with extreme precipitation events. The later often results in flooding and landslides with dramatic consequences on society. Along the same line, the characterization of ARs and their impact on precipitation (annual accumulation and extreme events) may be useful for precipitation forecast guidance. Finally, our climatology of ARs in southern South America will be compared with those obtained along the west coast of North America, an area that shares many geographical similarities with the region studied here, but also exhibits some differences, adding further diversity to the global survey of ARs.

2) RESULTS

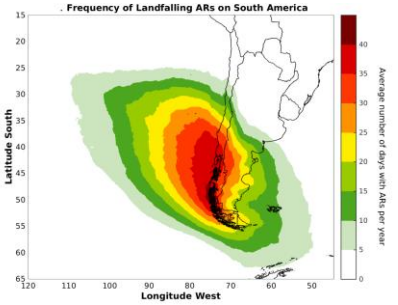
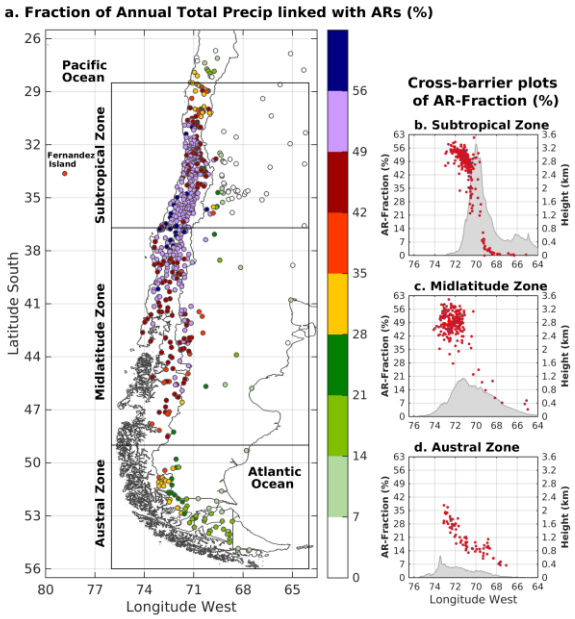


Figure 1: Annual frequency of landfalling ARs on South America for the 2001-2016 period. Units are expressed in the average number of days with ARs per year.

The analysis only represents those ARs that, at some moment of their lifecycle, made landfall along the west coast of South America. The AR frequency was calculated as the average number of days per year meeting the AR identification criteria (Fig. 1). At least one of the four reanalysis times per day (6-h IVT analysis) must meet the AR identification criteria to be considered as a day with AR conditions. ARs make landfall all along the west coast from 25°S to the southern tip of the continent (about 3000 km in length), but most frequently (35-40 days per year) between 38°S and 52°S and with an absolute maximum of 40-45 days at ~48°S. The AR frequency along the coast and offshore decreases rapidly to the south of 51°S and to the north of 35°S. The frequency of time in which a landfalling AR affected the interior of the continent decreased sharply to east of the Andes, especially at subtropical latitudes where the mountains are high.



The contribution of ARs to the annual total precipitation is largest along the subtropical west coast, with values between 49% and 63%. This contribution reduces markedly to the north of 32°S (< 8% at windward-side stations) due to the sharp reduction in AR occurrence (Fig. 1). To the east of the subtropical Andes (roughly delimited by the Chile-Argentina border) ARs are rather infrequent and have a small contribution to total precipitation (less than 15%). In midlatitudes (39°S-49°S), the AR contribution to the total precipitation is still large (42% to 56 %) both along the coast and even in some stations immediately to the east of the Andes crest. Farther east the AR contribution decreases down to less than 10% near the Atlantic sea border, despite a moderate AR frequency (Fig. 4).

Figure 2: (a) Fraction of annual total precipitation associated with AR conditions over the 2001-2016 period. Fractions are multiplied by 100 to express the results in percentage. AR fractions at each station site are calculated using daily rain dataset. Cross-barrier plots of the AR-Fraction for the (b) Subtropical, (c) Midlatitude, and (d) Austral zones. The limits of each zone are defined in the plan-view plot of the panel (a). The meridionally averaged west-east cross-sections of the topography (within the rectangle shown in panel a) are shown in panels (b)-(d) as a reference.

South of 47°S nearly all the stations are located to the east of the austral Andes but the AR contribution ranges from 40% for stations immediately to the lee to less than 15% for stations farther east close to the Atlantic coast. In comparison with previous studies in the west coast of North America, the percentages of AR contribution to total precipitation in South America are quite similar, except for the central Chile region where they are slightly higher, which could be attributed to different methodology and stronger orographic effect as discussed below.

REFERENCIAS

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